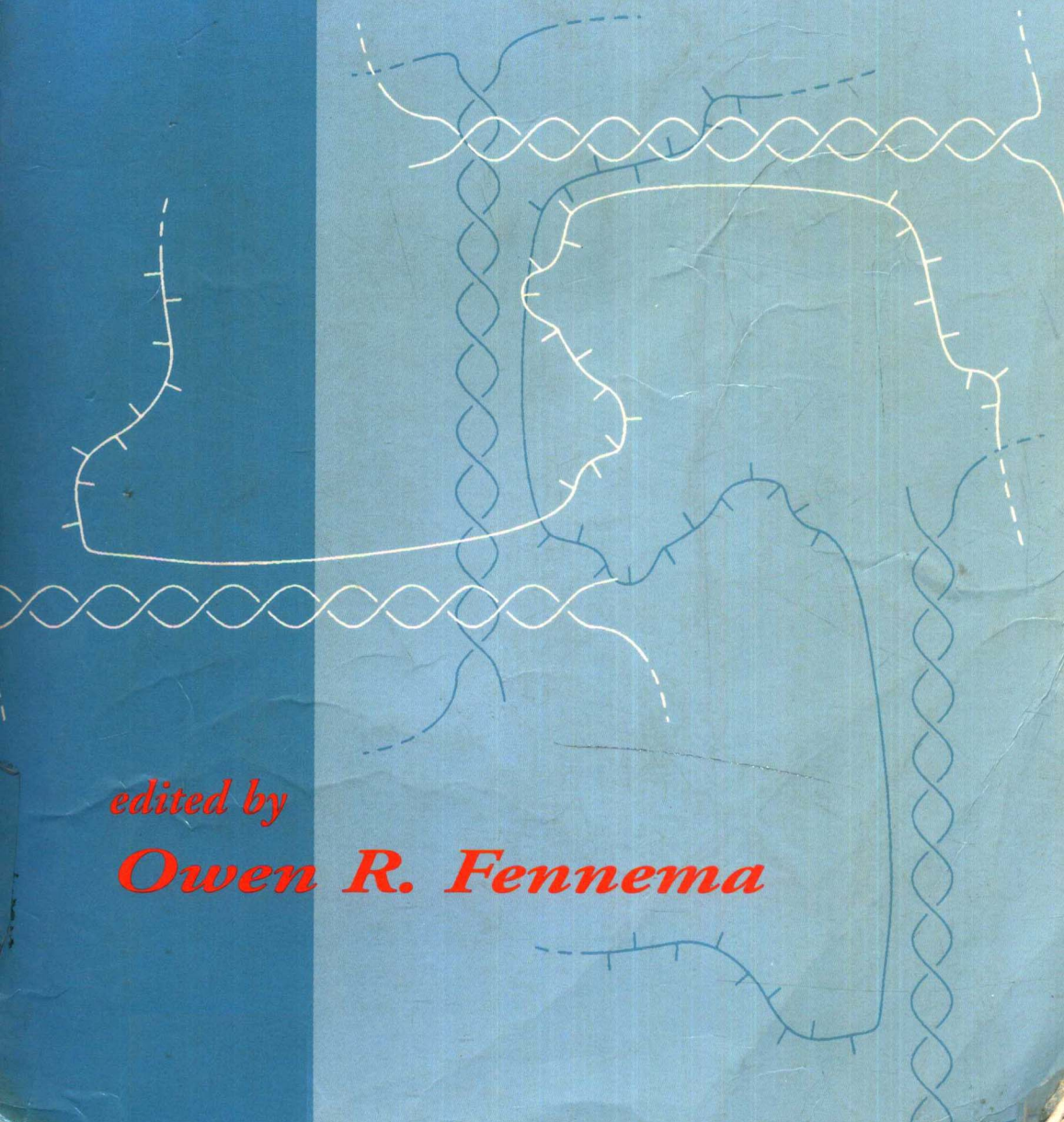
FOOD CHEMISTRY

THIRD EDITION



edited by

Owen R. Fennema

FOOD CHEMISTRY

THIRD EDITION

edited by

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Preface to the Third Edition

More than a decade has passed since the publication of the second edition of *Food Chemistry,* so the appropriateness of an updated version should be apparent. The purposes of the book remain unchanged: it is primarily a textbook for upper division undergraduates and beginning graduate students who have sound backgrounds in organic chemistry and biochemistry, and is secondarily a reference book. Information on food analysis is intentionally absent, except where its presence fits logically with the topic under discussion. As a textbook for undergraduates, it is designed to serve as the basis of a two-semester course on food chemistry with the assumption that the instructor will make selective reading assignments as deemed appropriate. Individual chapters in the book should be useful as the basis of graduate-level courses on specialized topics in food chemistry.

The third edition differs in several important respects from the second. The chapters prepared by first-time contributors are totally new. These cover such topics as proteins, dispersions, enzymes, vitamins, minerals, animal tissues, toxicants, and pigments. Chapters by contributors to the second edition have been thoroughly revised. For example, in the chapter "Water and Ice," a major addition deals with molecular mobility and glass transition phenomena. The result is a book that is more than 60% new, has greatly improved graphics, and is better focused on material that is unique to food chemistry.

Chapters have been added on the topics of dispersions and minerals. In the second edition, treatment of dispersions was accomplished in the chapters "Lipids," "Proteins," and "Carbohydrates," and minerals were covered in the chapter "Vitamins and Minerals." Although this was organizationally sound, the result was superficial treatment of dispersions and minerals. The new chapters on these topics provide depth of coverage that is more consistent with the remainder of the book. Associated with these changes is a chapter, written by a new contributor, that is now devoted solely to vitamins. It is my belief that this chapter represents the first complete, in-depth treatise on vitamins with an emphasis on food chemistry.

I would be remiss not to thank the contributors for their hard work and tolerance of my sometimes severe editorial oversight. They have produced a book that is of first-rate quality. After twenty years and two previous editions, I am finally satisfied that all major topics are covered appropriately with regard to breadth and depth of coverage, and that a proper focus on reactions pertaining specifically to foods has been achieved. This focus successfully dis-

tinguishes food chemistry from biochemistry in the same sense that biochemistry is distinct from, yet still dependent on, organic chemistry.

Although I have planned and edited this edition with great care, minor errors are inevitable, especially in the first printing. If these are discovered, I would very much appreciate hearing from you so that corrections can be effected promptly.

Owen R. Fennema

Preface to the Second Edition

Considerable time has passed since publication of the favorably received first edition so a new edition seems appropriate. The purpose of the book remains unchanged—it is intended to serve as a textbook for upper division undergraduates or beginning graduate students who have sound backgrounds in organic chemistry and biochemistry, and to provide insight to researchers interested in food chemistry. Although the book is most suitable for a two-semester course on food chemistry, it can be adapted to a one-semester course by specifying selective reading assignments. It should also be noted that several chapters are of sufficient length and depth to be useful as primary source materials for graduate-level specialty courses.

This edition has the same organization as the first, but differs substantially in other ways. The chapters on carbohydrates, lipids, proteins, flavors, and milk and the concluding chapter have new authors and are, therefore, entirely new. The chapter on food dispersions has been deleted and the material distributed at appropriate locations in other chapters. The remaining chapters, without exception, have been substantially modified, and the index has been greatly expanded, including the addition of a chemical index. Furthermore, this edition, in contrast to the first, is more heavily weighted in the direction of subject matter that is unique to food chemistry, i.e., there is less overlap with materials covered in standard biochemistry courses. Thus the book has undergone major remodeling and refinement, and I am indebted to the various authors for their fine contributions and for their tolerance of my sometimes severe editorial guidance.

This book, in my opinion, provides comprehensive coverage of the subject of food chemistry with the same depth and thoroughness that is characteristic of the better quality introductory textbooks on organic chemistry and biochemistry. This, I believe, is a significant achievement that reflects a desirable maturation of the field of food chemistry.

Owen R. Fennema

Preface to the First Edition

For many years, an acute need has existed for a food chemistry textbook that is suitable for food science students with backgrounds in organic chemistry and biochemistry. This book is designed primarily to fill the aforementioned need, and secondarily, to serve as a reference source for persons involved in food research, food product development, quality assurance, food processing, and in other activities related to the food industry.

Careful thought was given to the number of contributors selected for this work, and a decision was made to use different authors for almost every chapter. Although involvement of many authors results in potential hazards with respect to uneven coverage, differing philosophies, unwarranted duplication, and inadvertent omission of important materials, this approach was deemed necessary to enable the many facets of food chemistry to be covered at a depth adequate for the primary audience. Since I am acutely aware of the above pitfalls, care has been taken to minimize them, and I believe the end product, considering it is a first edition, is really quite satisfying—except perhaps for the somewhat generous length. If the readers concur with my judgment, I will be pleased but unsurprised, since a book prepared by such outstanding personnel can hardly fail, unless of course the editor mismanages the talent.

Organization of the book is quite simple and I hope appropriate. Covered in sequence are major constituents of food, minor constituents of food, food dispersions, edible animal tissues, edible fluids of animal origin, edible plant tissues and interactions among food constituents—the intent being to progress from simple to more complex systems. Complete coverage of all aspects of food chemistry, of course, has not been attempted. It is hoped, however, that the topics of greatest importance have been treated adequately. In order to help achieve this objective, emphasis has been given to broadly based principles that apply to many foods.

Figures and tables have been used liberally in the belief that this approach facilitates understanding of the subject matter presented. The number of references cited should be adequate to permit easy access to additional information.

To all readers I extend an invitation to report errors that no doubt have escaped my attention, and to offer suggestions for improvements that can be incorporated in future (hopefuly) editions.

Since enjoyment is an unlikely reader response to this book, the best I can hope for is that readers will find it enlightening and well suited for its intended purpose.

Owen R. Fennema

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1.1 WHAT IS FOOD CHEMISTRY?

Concern about food exists throughout the world, but the aspects of concern differ with location. In underdeveloped regions of the world, the bulk of the population is involved in food production, yet attainment of adequate amounts and kinds of basic nutrients remains an ever-present problem. In developed regions of the world, food production is highly mechanized and only a small fraction of the population is involved in this activity. Food is available in abundance, much of it is processed, and the use of chemical additives is common. In these fortunate localities, concerns about food relate mainly to cost, quality, variety, convenience, and the effects of processing and added chemicals on wholesomeness and nutritive value. All of these concerns fall within the realm of food science—a science that deals with the physical, chemical, and biological properties of foods as they relate to stability, cost, quality, processing, safety, nutritive value, wholesomeness, and convenience.

Food science is an interdisciplinary subject involving primarily bacteriology, chemistry,